BASIC PLC
Programmable Logic Controller

Dr.Abdelazeem A. Esmail

Lecturer – Faculty of Tec. Ind. & Energy

Delta Technological University

2025 / 2026

PLC Course

01

Introduction

Numbering System, Logic Gate, Flip Flop, Register, Decoder, Tri-State Buffer, Latch, I/O Port , Memory, Microprocessor, Microcontroller/DSP, PLC/DDC

02

PLC H/W

What and Why?, PLC Construction, Memory, I/O modules, Special Modules, PLC Type

03

PLC S/W

PLC Programming
Ladder
Instruction list
Function chart

04

Control Problem

classification and Examples on
1-Interlock Control Problems
2-Sequential Control Problems 3-Random Control Problem

02

PLC H/W

What and Why?, PLC Construction, Memory, I/O modules, PLC Programming Special Modules, PLC Type

Programmable Logic Controllers

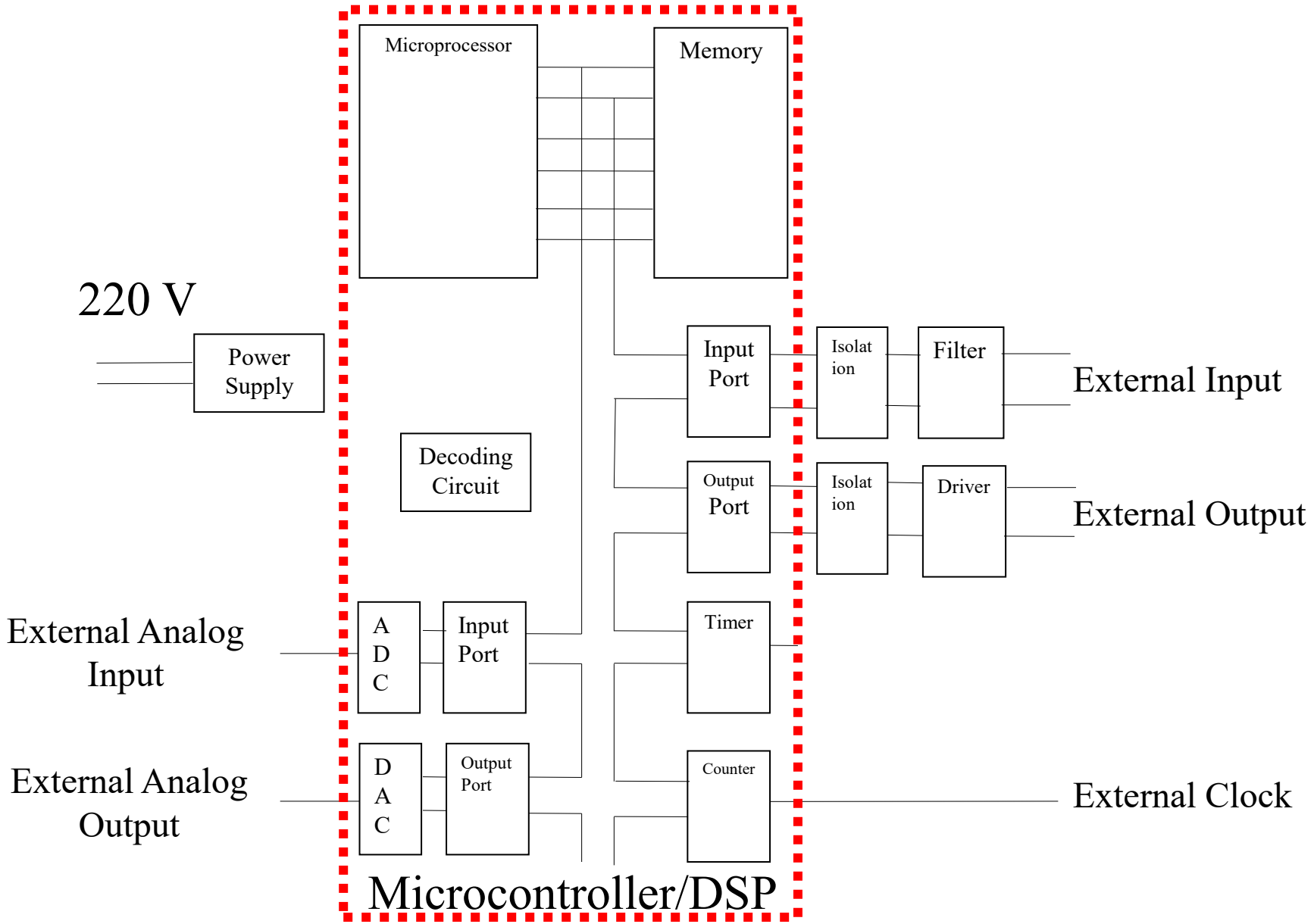
PLC Construction

- What & Why
- Memory
- I/O Modules
- PLC Programming
- Special Modules
- PLC Type

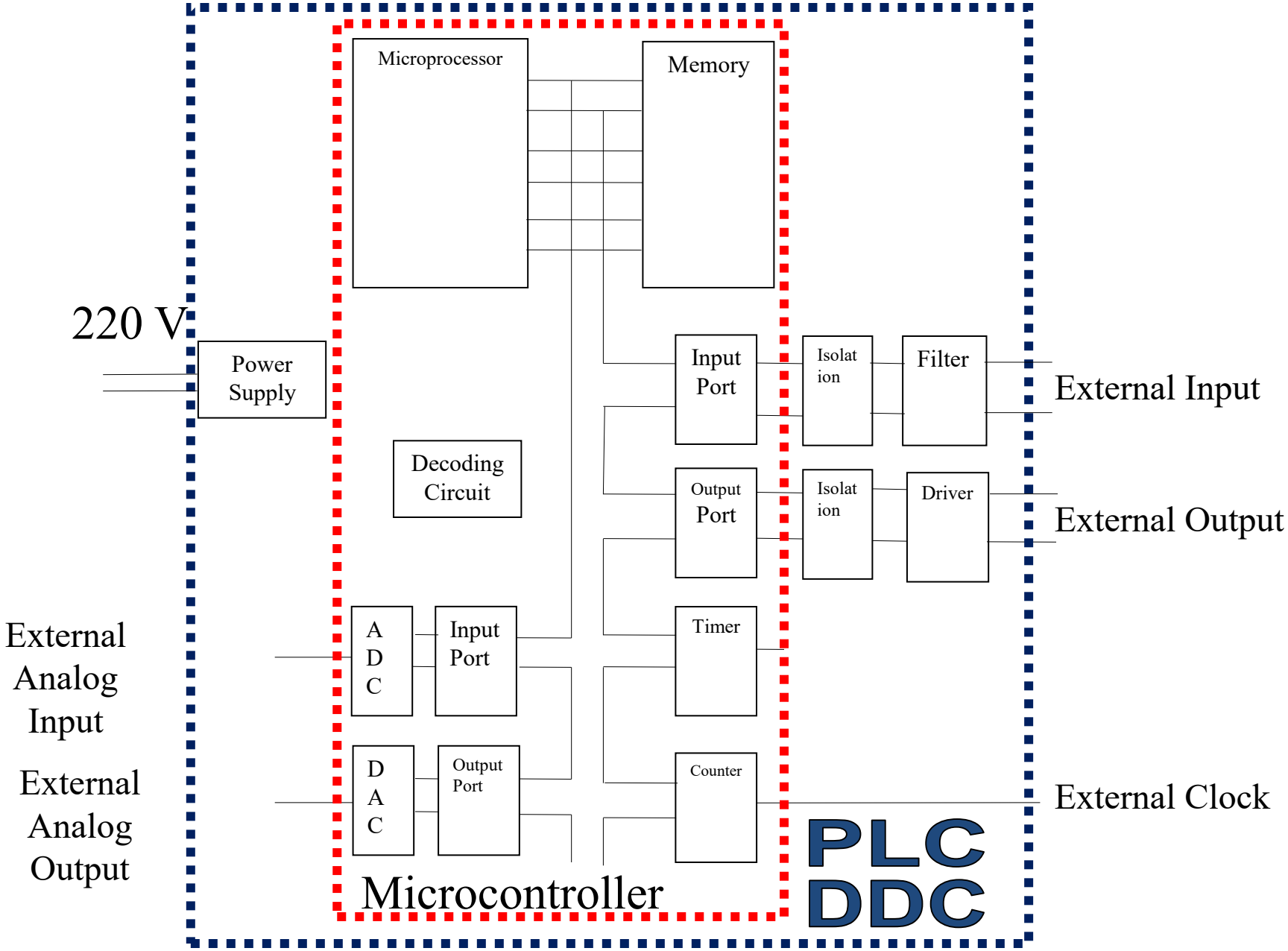
What is the PLC

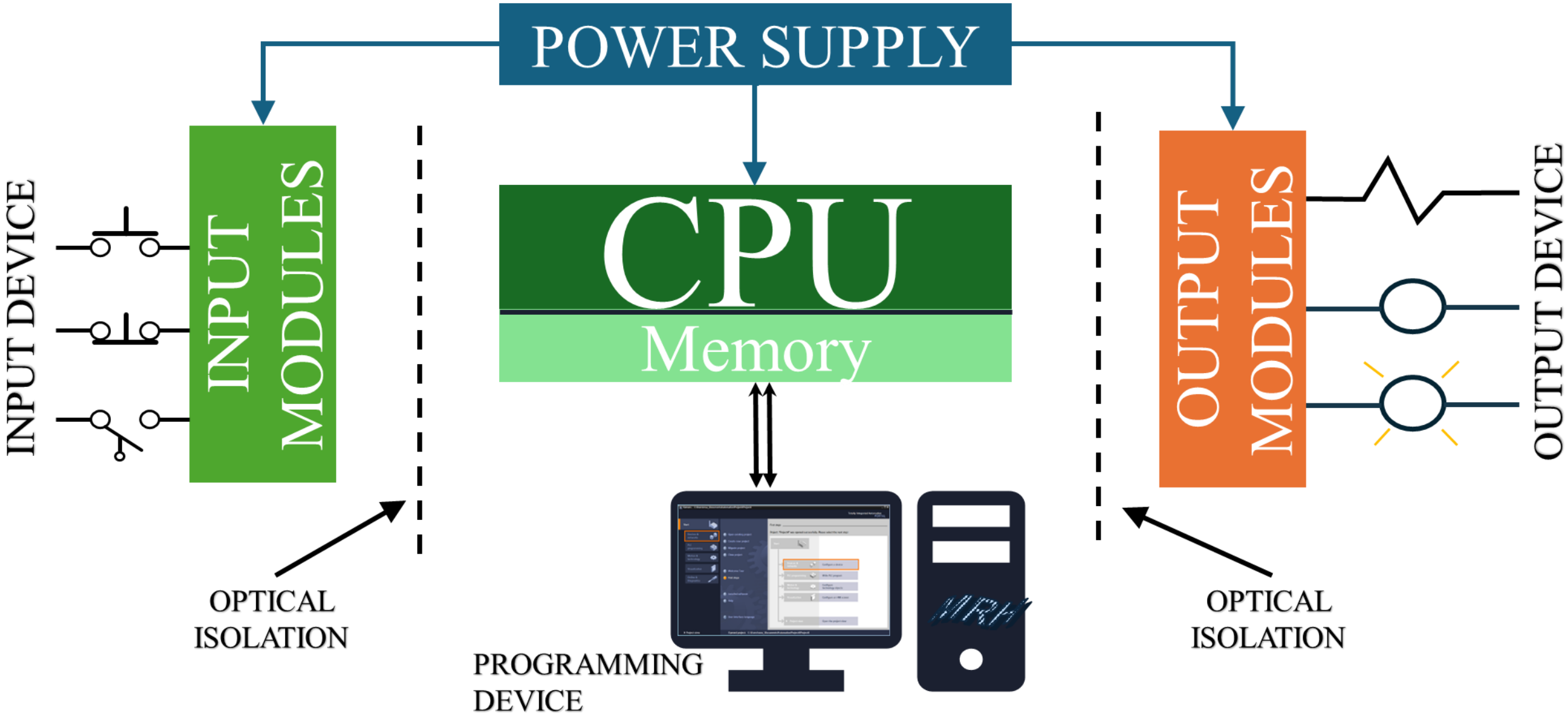
A Programmable Logic Controller (PLC) is an industrial digital computer specially designed to control manufacturing processes, machinery, or any automated system.
Main Purpose: To monitor inputs, make decisions based on logic, and control outputs in real time.

Microprocessor Based Control System



Microprocessor Based Control System




POWER SUPPLY
CPU
Memory
INPUT DEVICE
INPUT MODULES
OUTPUT MODULES
OUTPUT DEVICE
OPTICAL ISOLATION
OPTICAL ISOLATION
PROGRAMMING DEVICE

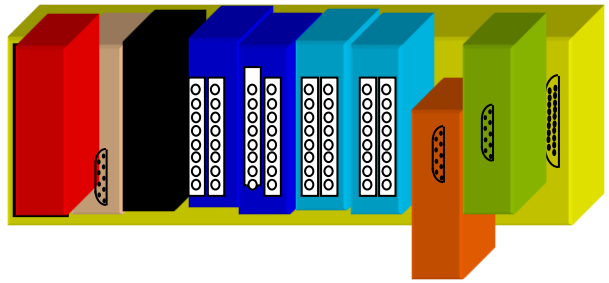
The PLC consists of

1-CPU
2- Input module
3- Output module
4-Memory
5-Power supply

Memory		
Input Module	CPU	Input Module
Power Supply		

Components in a PLC system

- CPU module, containing the processor and memory
- Input and output modules, to allow the PLC to read sensors and control actuators – A wide variety of types are available
- Power supply for the PLC, and often sensors and low power actuators connected to I/O modules
- A rack or bus so the PLC can exchange data with I/O modules



Why PLC

Preferred compared with computers

1-Noise immunity

2-Rugged

3-Input/output modules

- Modular
- Standard

4-Language

- Easy to learn
- Easy to be used in control

PLC Advantages

- **Flexibility**

Now it is possible to use just one model of a PLC to run any one of the 15 machines.

- **Implementing Changes and Correcting Errors**

if a programming error has to be corrected in a PLC control ladder diagram, a change can be typed in quickly.

- **Large Quantities of Contacts**

Contacts are now a “software” component

- **Lower Cost**

Increased technology makes it possible to condense more functions into smaller and less expensive packages.

• Pilot Running

A PLC programmed circuit can be evaluated in the lab. The program can be typed in, tested, observed, and modified if needed, saving valuable factory time.

• Visual Observation

A PLC circuit's operation can be seen during operation directly on a CRT screen.

• Ladder or Boolean Programming Method

PLC programmer who works in digital or Boolean control systems can also easily perform PLC programming.

• Reliability and Maintainability

Solid-state devices are more reliable, in general, than mechanical systems or relays and timers. Consequently, the control system maintenance costs are low and downtime is minimal.

PLC Disadvantages

- **Fixed Program Applications**

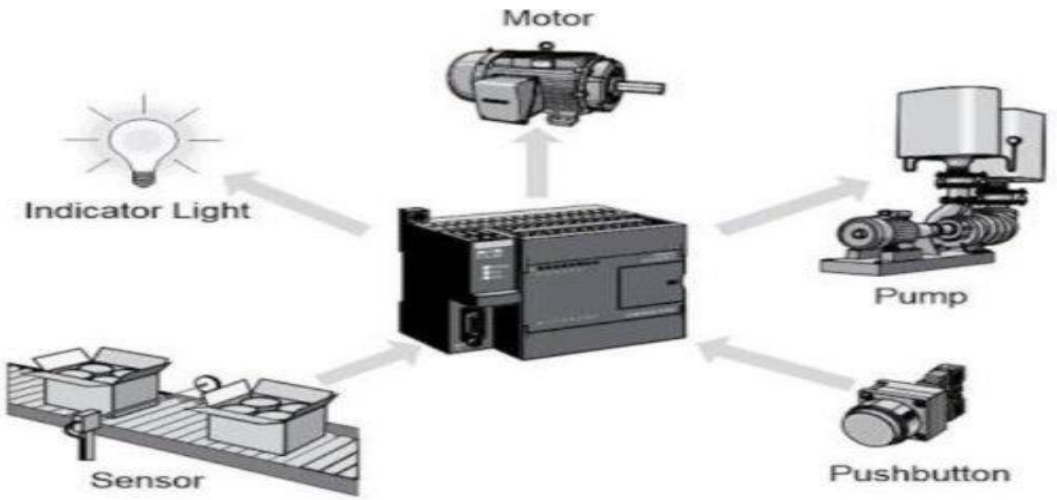
– Some applications are single-function applications. It does not pay to use a PLC that includes multiple programming capabilities if they are not needed.

– Their operational sequence is seldom or never changed, so the reprogramming available with the PLC would not be necessary.

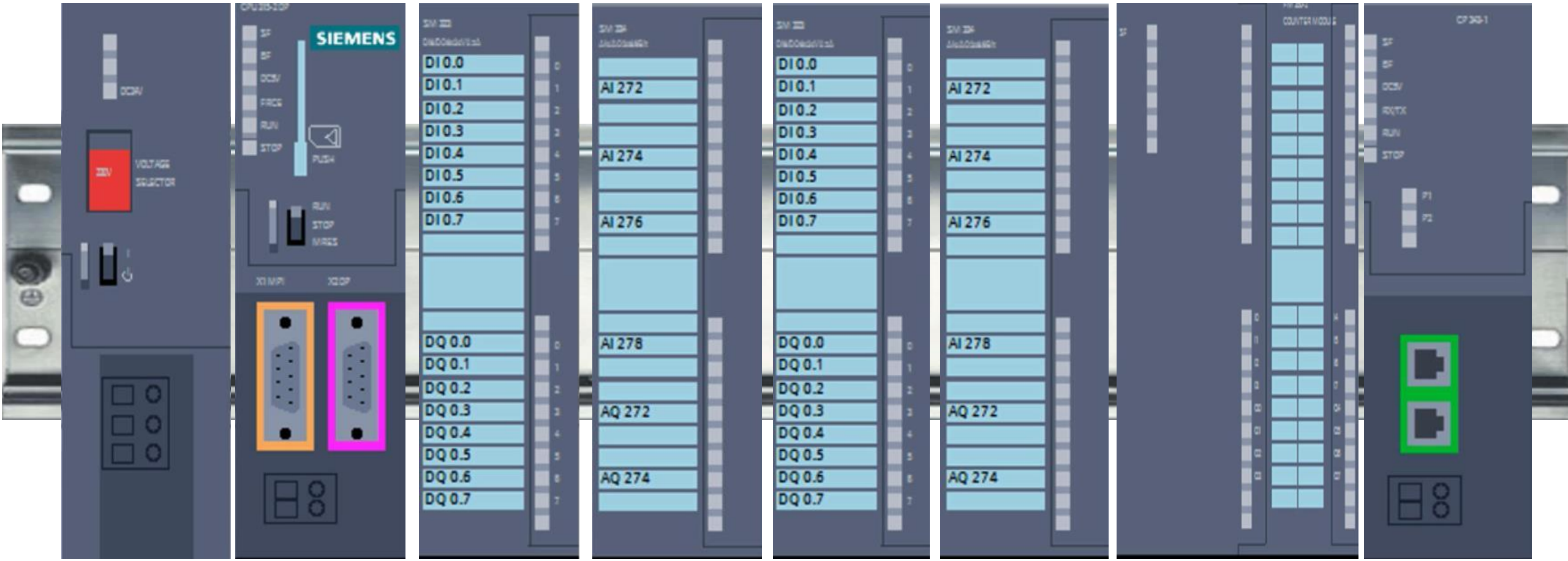
- **Fail-Safe Operation**

– In relay systems, the stop button electrically disconnects the circuit; if the power fails, the system stops.

– This, of course, can be programmed into the PLC; however, in some PLC programs, you may have to apply an input voltage to cause a device to stop. These systems may not be fail-safe.



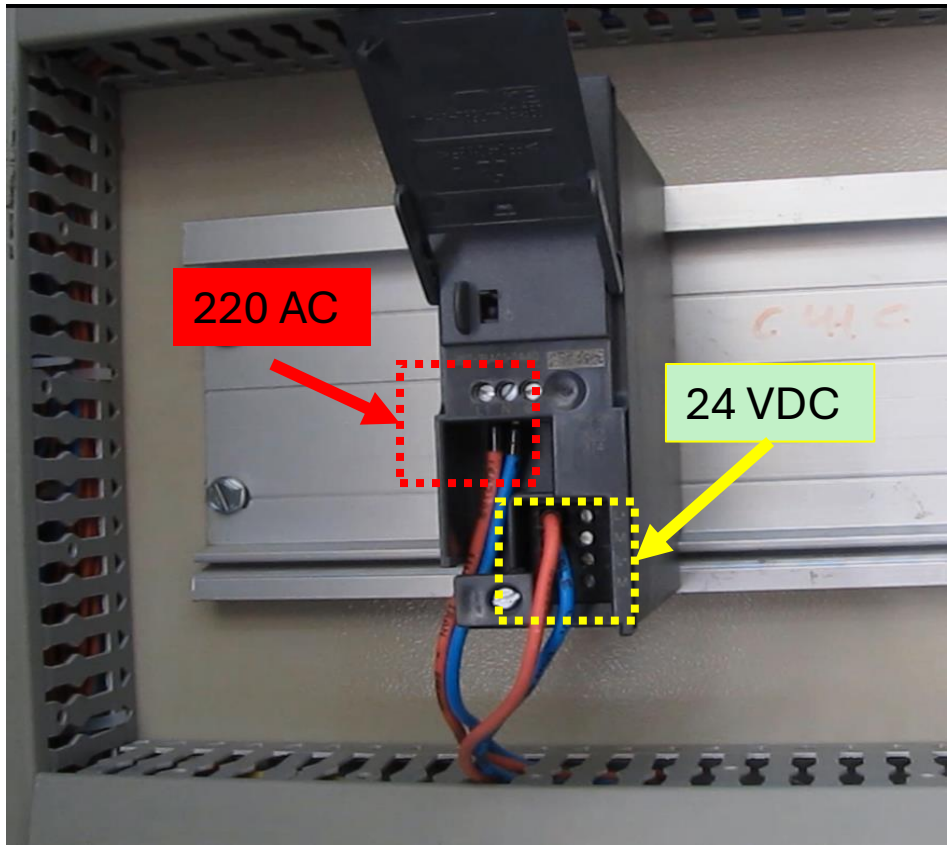
Parts of a PLC Power Supply

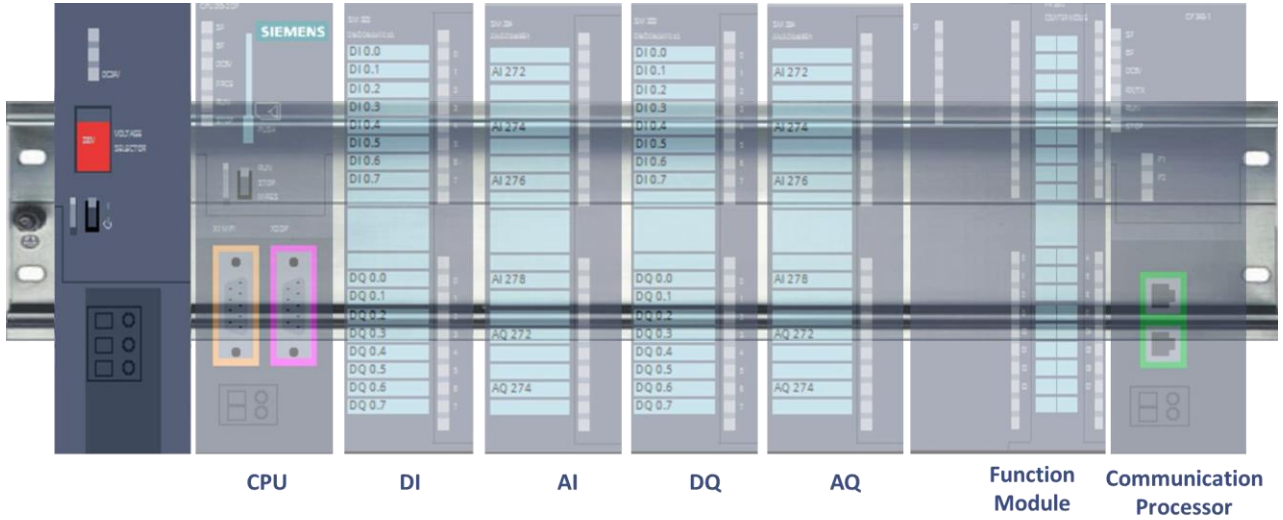


Power Supply | CPU | DI | AI | DQ | AQ | Function Module | Communication Processor

Parts of a PLC Power Supply

The PLC power supply provides the necessary power (typically 5 VDC / 24 VDC) to the processor and I/O modules plugged into the backplane of the rack

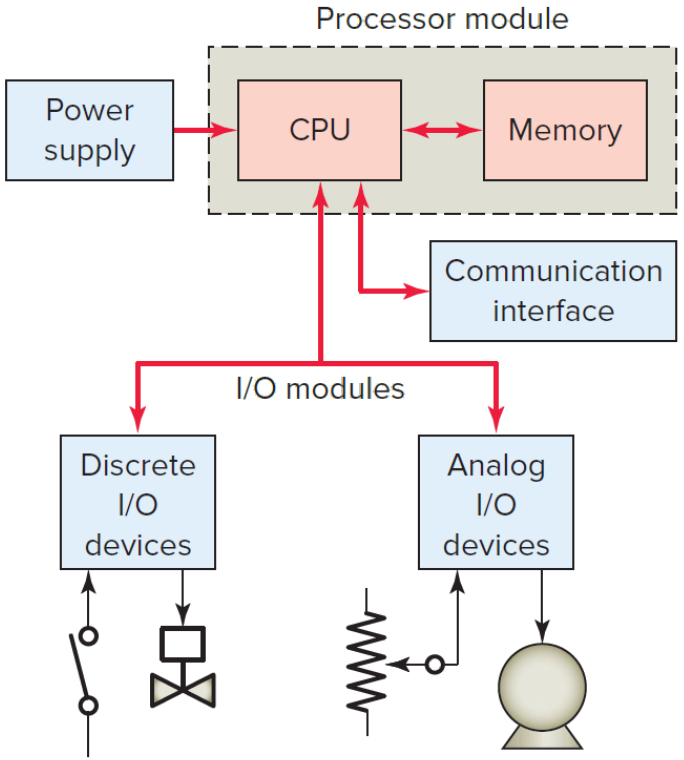


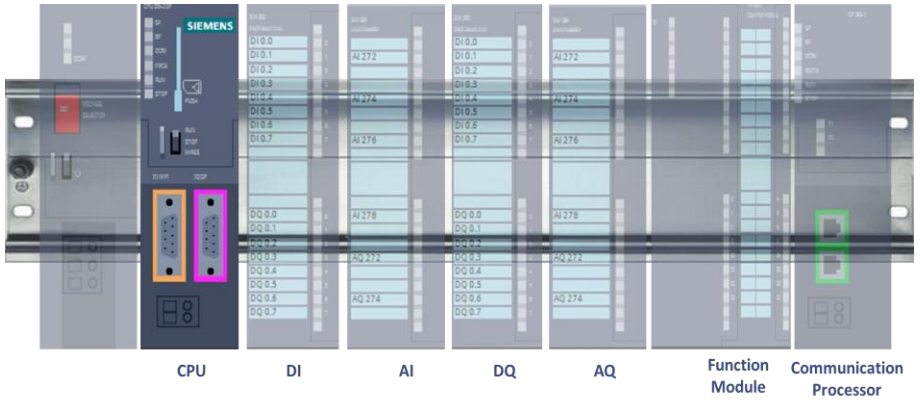


Parts of a PLC CPU

The Central Processing Unit (CPU) is built into single-unit fixed PLCs while modular rack types typically use a plugin module.

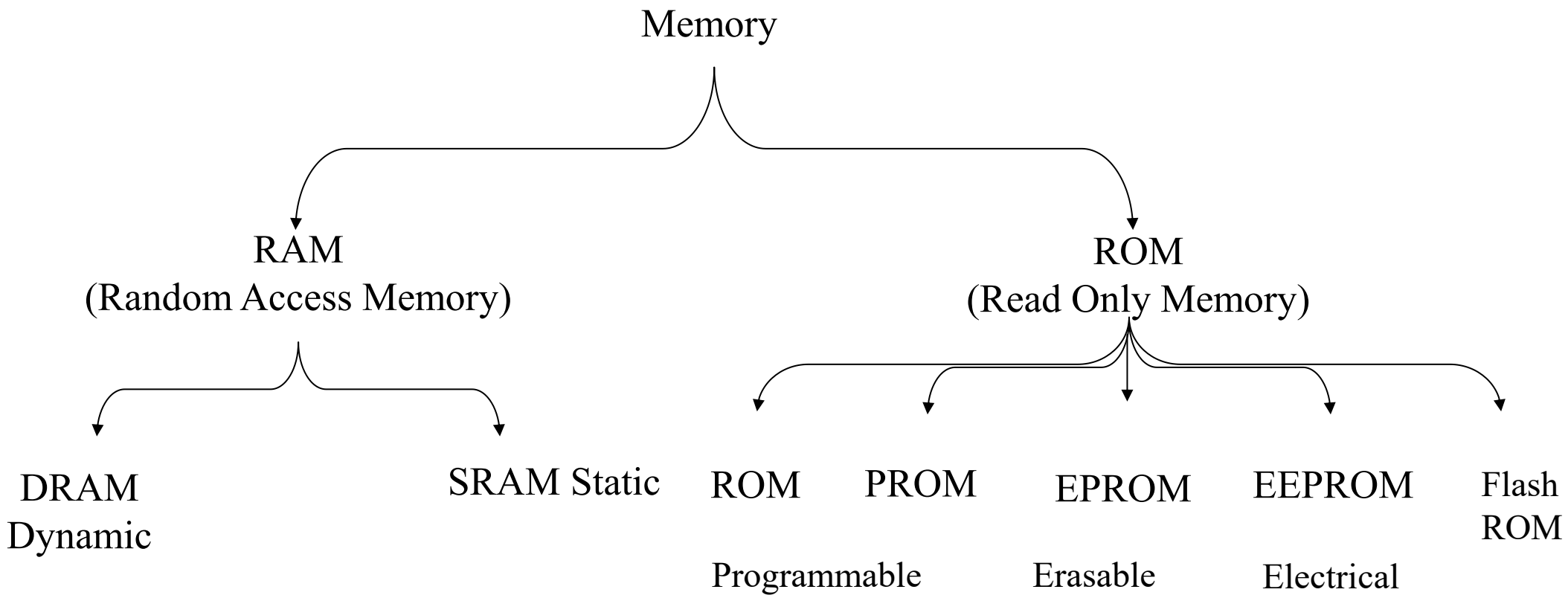
- **A processor module can be divided into two sections: the CPU section and the memory section.**





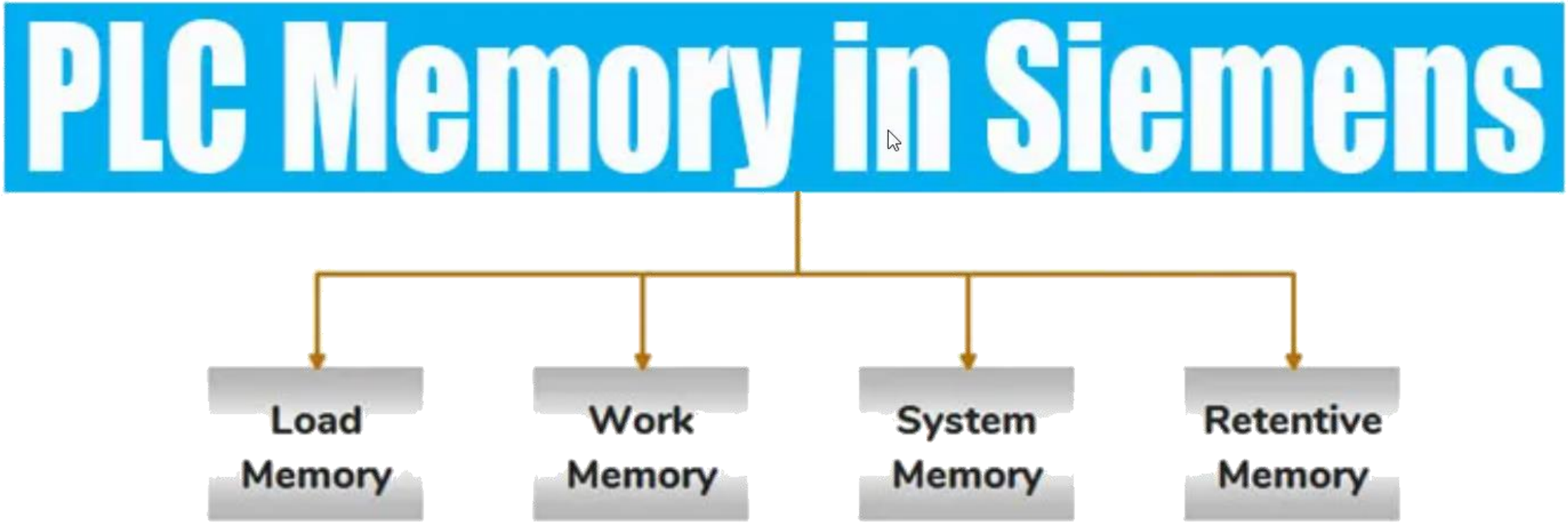
Memory

General type of Memory



Memory

But in PLC the issue is a little different. How is it different? Companies use the types mentioned above, but each company creates its own structure.



Memory

Load Memory

Load memory is a non-volatile storage memory for the user program, data, and configuration. Therefore, when a program is downloaded to the CPU, it will first be stored in the load memory area.

Work Memory

Work memory is volatile storage for some elements of the user program while executing the program. **Work memory is like the RAM of a computer.**

system memory

System memory can store all the addressing parts of the user program like addressing inputs, outputs, timers, counters, and bit memory.

Memory	
Work memory	
• integrated	100 kbyte
• expandable	No
Load memory	
• integrated	4 Mbyte
• Plug-in (SIMATIC Memory Card), max.	with SIMATIC memory card
Backup	
• present	Yes
• maintenance-free	Yes
• without battery	Yes

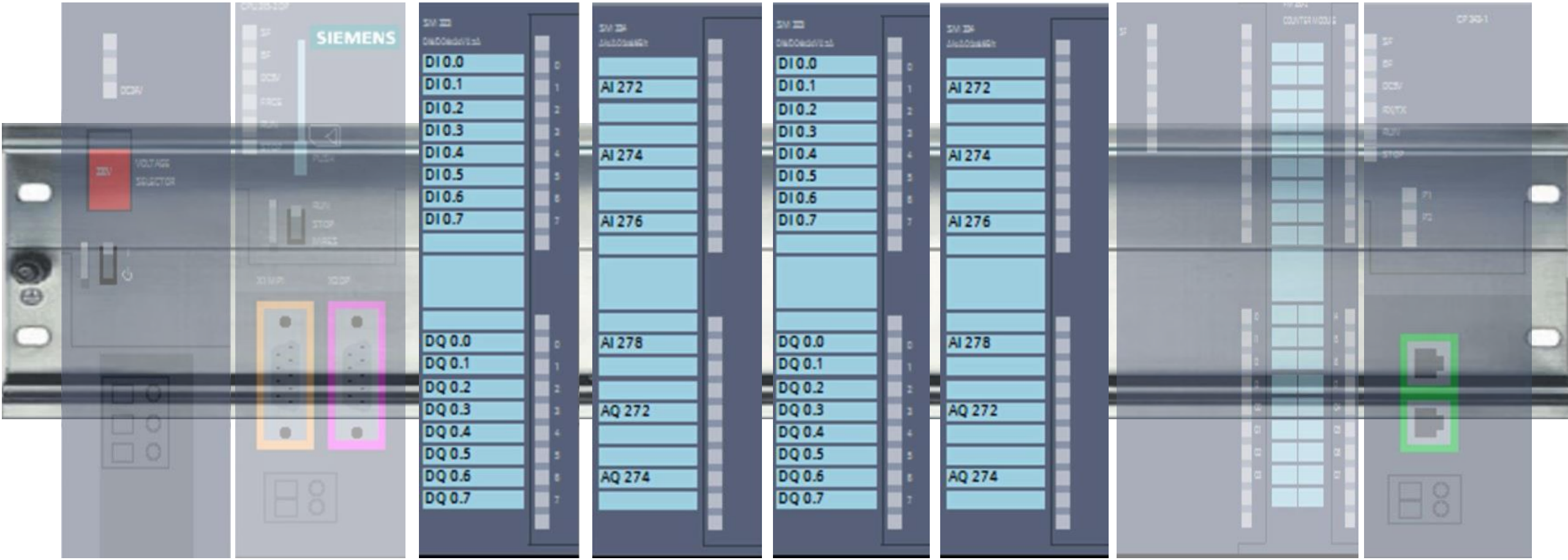
Page 2
Data sheet 6ES7214-1BG40-0XB0

SIEMENS

Data sheet 6ES7214-1BG40-0XB0

SIMATIC S7-1200, CPU 1214C, compact CPU, AC/DC/relay, onboard I/O: 14 DI 24 V DC; 10 DO relay 2 A; 2 AI 0-10 V DC, Power supply: AC 85-264 V AC at 47-63 Hz, Program/data memory 100 KB

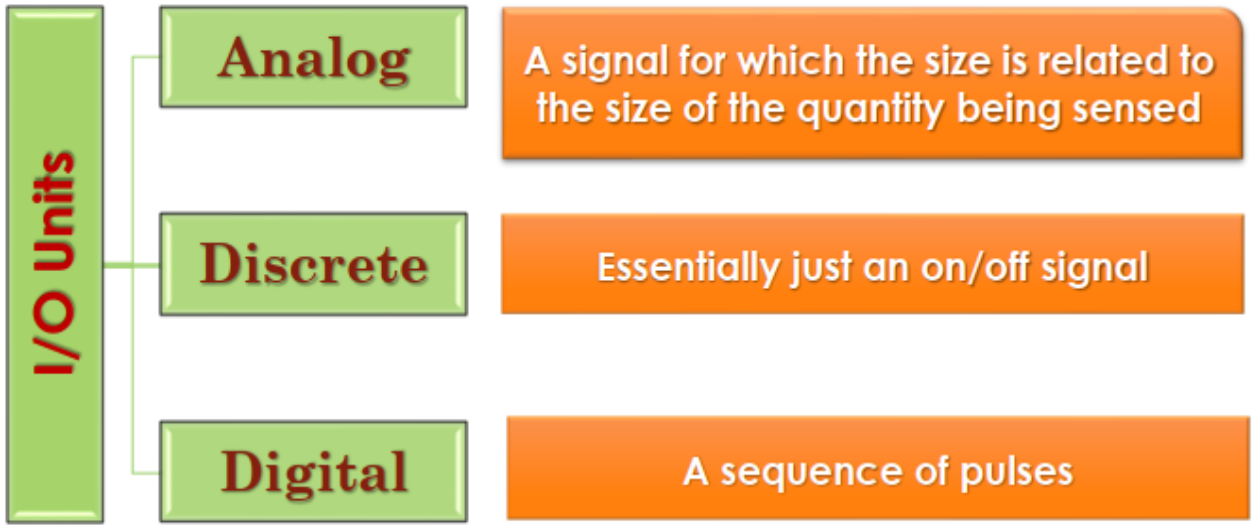
Parts of a PLC INPUT / OUTPUT UNITS



CPU DI AI DQ AQ Function Module Communication Processor

Parts of a PLC INPUT / OUTPUT UNITS

- **The CPU, however, must have an input of digital signals of a particular size, normally 0 to 5 V.**
- **The output from the CPU is digital, normally 0 to 5 V.**
- **Thus, there is generally a need to manipulate input and output signals so that they are in the required form.**
- Input signals from sensors and outputs required for actuating devices can be:


I/O Units
Analog
A signal for which the size is related to the size of the quantity being sensed
Discrete
Essentially just an on/off signal
Digital
A sequence of pulses

Discrete I/O Modules

- This type of interface connects field input devices of the ON/OFF nature such as selector switches, pushbuttons, and limit switches.

- Likewise, output control is limited to devices such as lights, relays, solenoids, and motor starters that require simple ON/OFF switching.

Discrete I/O Modules

Pushbuttons

AR22F0R-01RZA

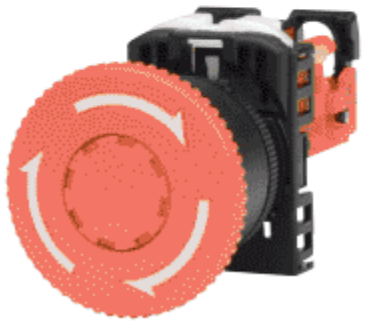
Illuminated Pushbuttons

AR22F0L-10E3YZA

Pilot Lights

DR22E3L-E3SZA

E-Stop Pushbuttons



AR22V0R-01R

Selector Switches

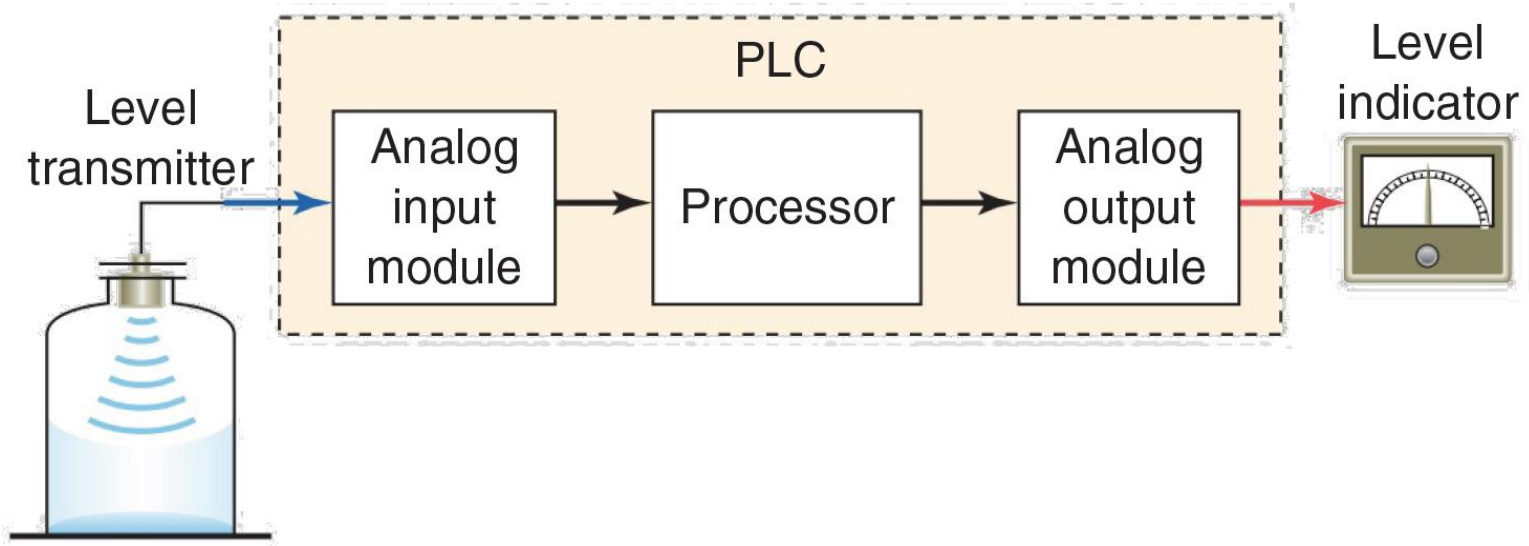
AR22PR-210BZA

Buzzers

DR22B8-EB

Analog I/O Modules

Discrete devices are inputs and outputs that have only two states: on and off. In comparison, analog devices (AI/AO) represent physical quantities that can have an infinite number of values.
Typical analog inputs and outputs vary from 0 to 20 mA, 4 to 20 mA, or 0 to 10 V.



Analog I/O Modules

- Analog voltage input modules are available in two types: unipolar and bipolar.
- Unipolar modules can accept an input signal that varies in the positive direction only. For example, if the field device outputs 0 to +10 V, then the unipolar modules would be used.
- Bipolar signals swing between a maximum negative value and a maximum positive value. For example, if the field device outputs −10 to +10 V a bipolar module would be used.
- The resolution of an analog input channel refers to the smallest change in input signal value that can be sensed and is based on the number of bits used in the digital representation.

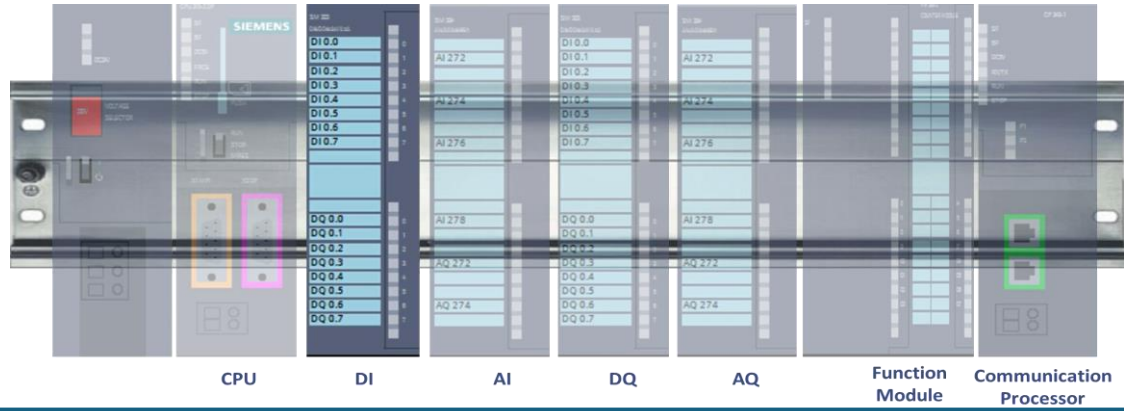
Span of analog input	Bipolar	10 V	−10 to +10 V
		5 V	−5 to +5 V
	Unipolar	10 V	0 to +10 V
		5 V	0 to +5 V
Resolution			0.3 mV

Parts of a PLC INPUT UNITS

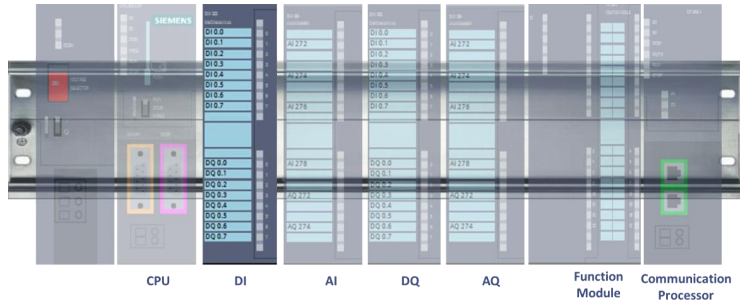
CPU DI AI DQ AQ Function Module Communication Processor

INPUT UNITS

- Opto-isolators are used to provide protection for the CPU.
- With the AC input unit, a rectifier bridge network is used to rectify the AC so that the resulting DC signal can provide the signal for use by the opto-isolator to give the input signals to the CPU of the PLC.
- Individual status lights are provided for each input to indicate when the input device is providing a signal.



INPUT UNITS



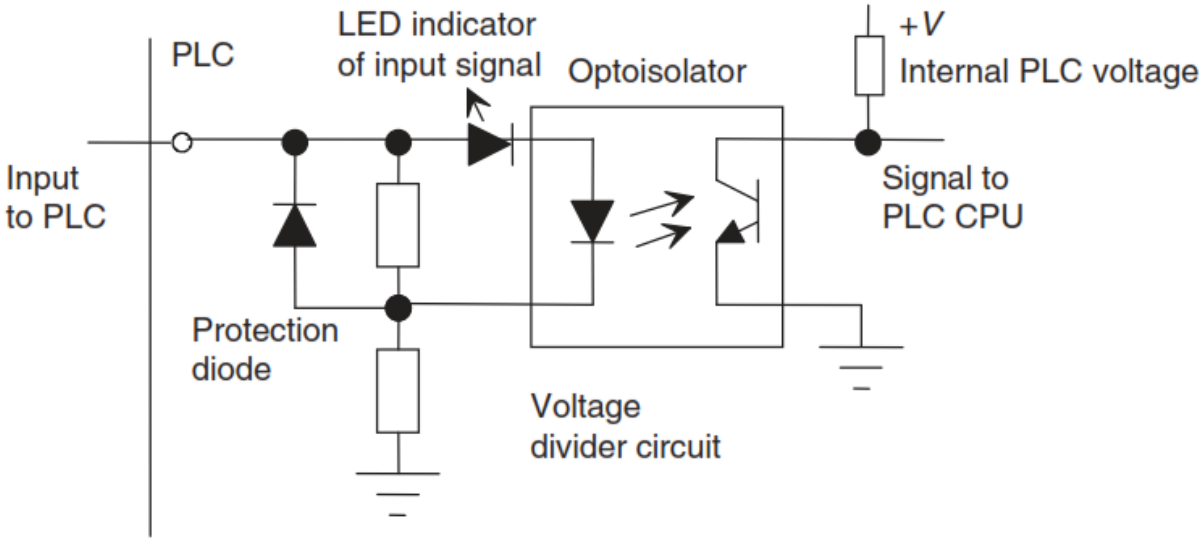


Figure 4.2: DC input unit.

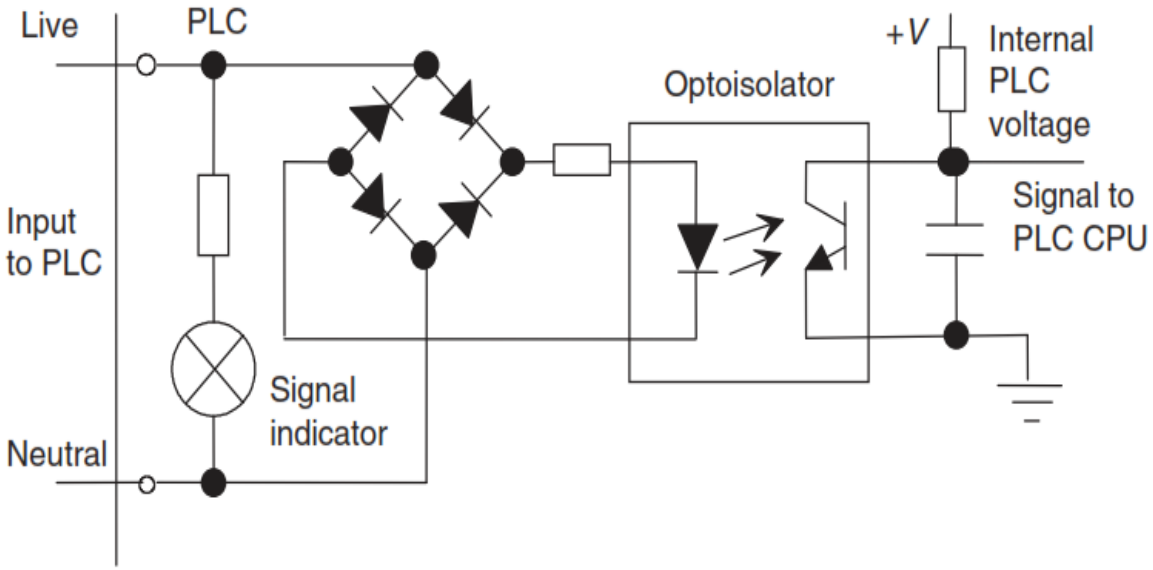


Figure 4.3: AC input unit.

Parts of a PLC Output unit

CPU DI AI DQ AQ Function Module Communication Processor

Output unit

I. Output Relay
II. Output solid state
    A. Output transistor
    B. Output triac

Output unit

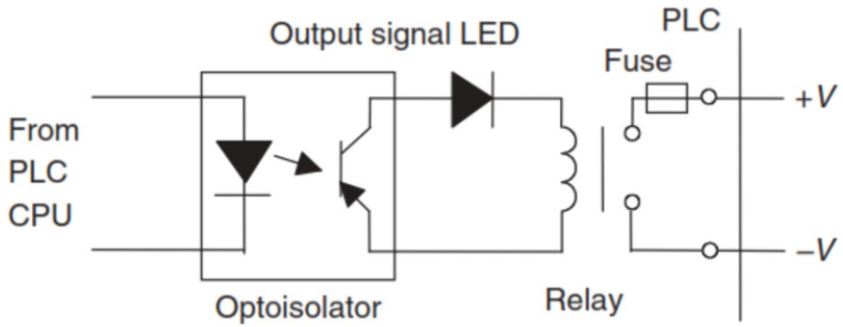


Figure 4.7: Relay output unit.

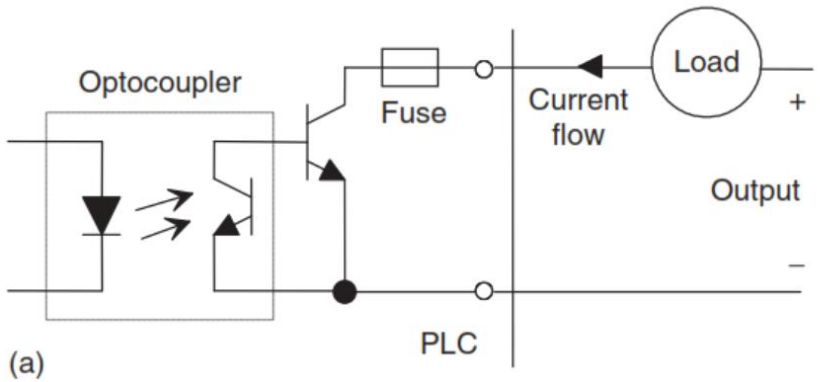


Figure 4.8 Output transistor

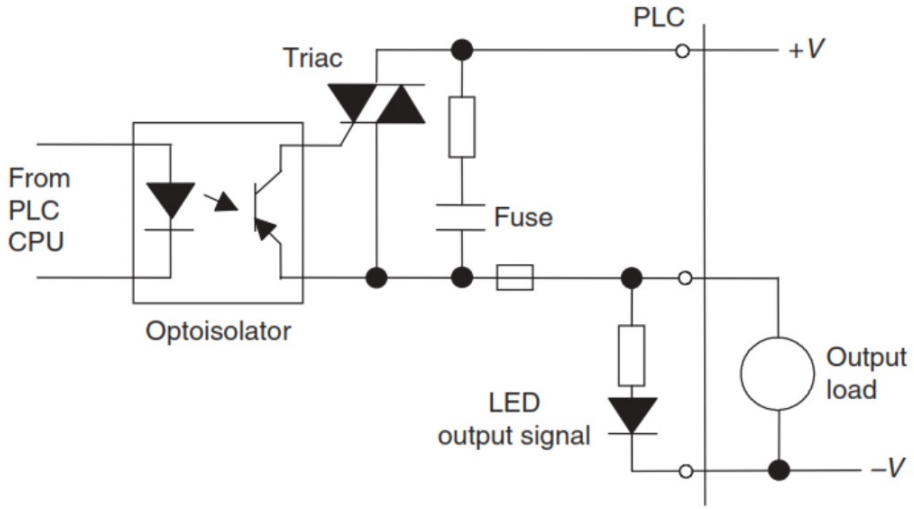
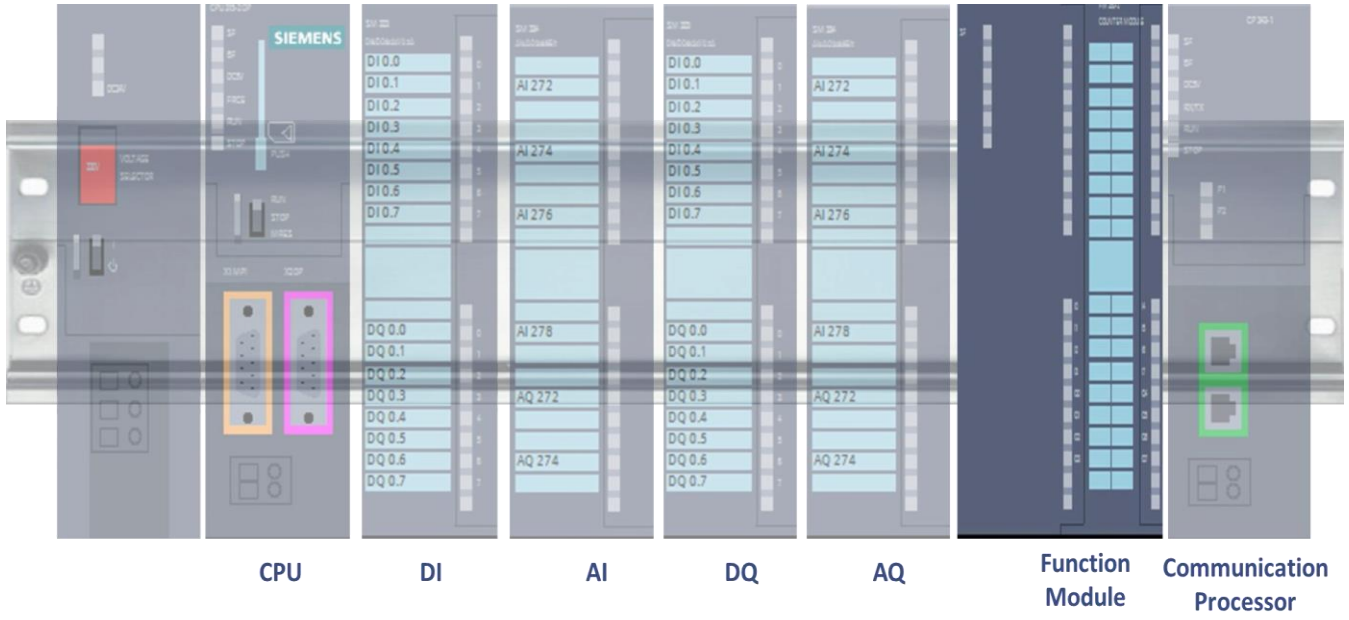


Figure 4.9: Triac output unit.

Parts of a PLC Function Module (FM)

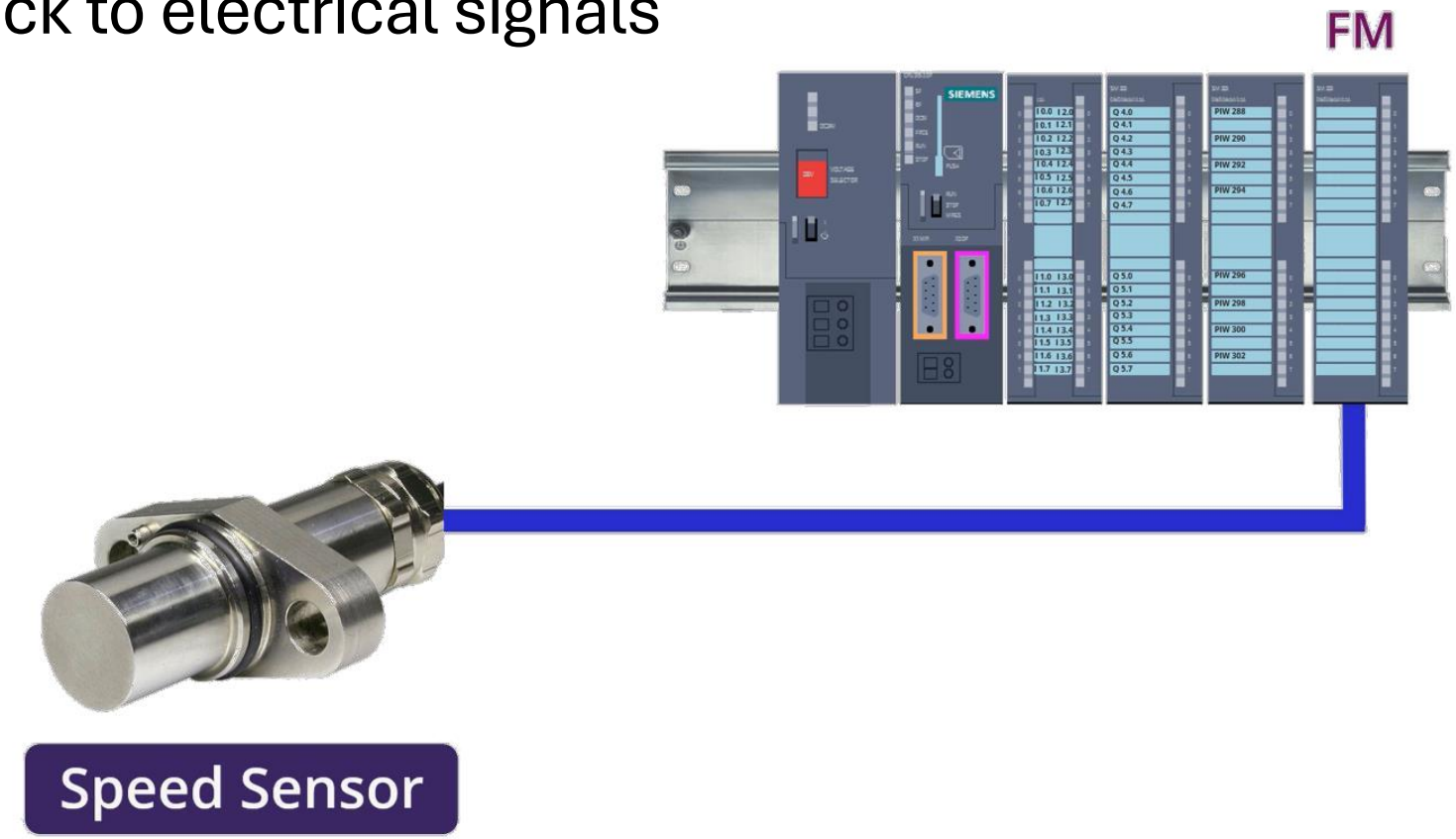
Function Module (FM)

- Function modules (FM) are intelligent modules that perform technological tasks such as position determination, counting and positioning, and other complex functions in the automation independently.
- They are used when there are high demands on accuracy and dynamic in the starting of automation tasks.



Function Module (FM)

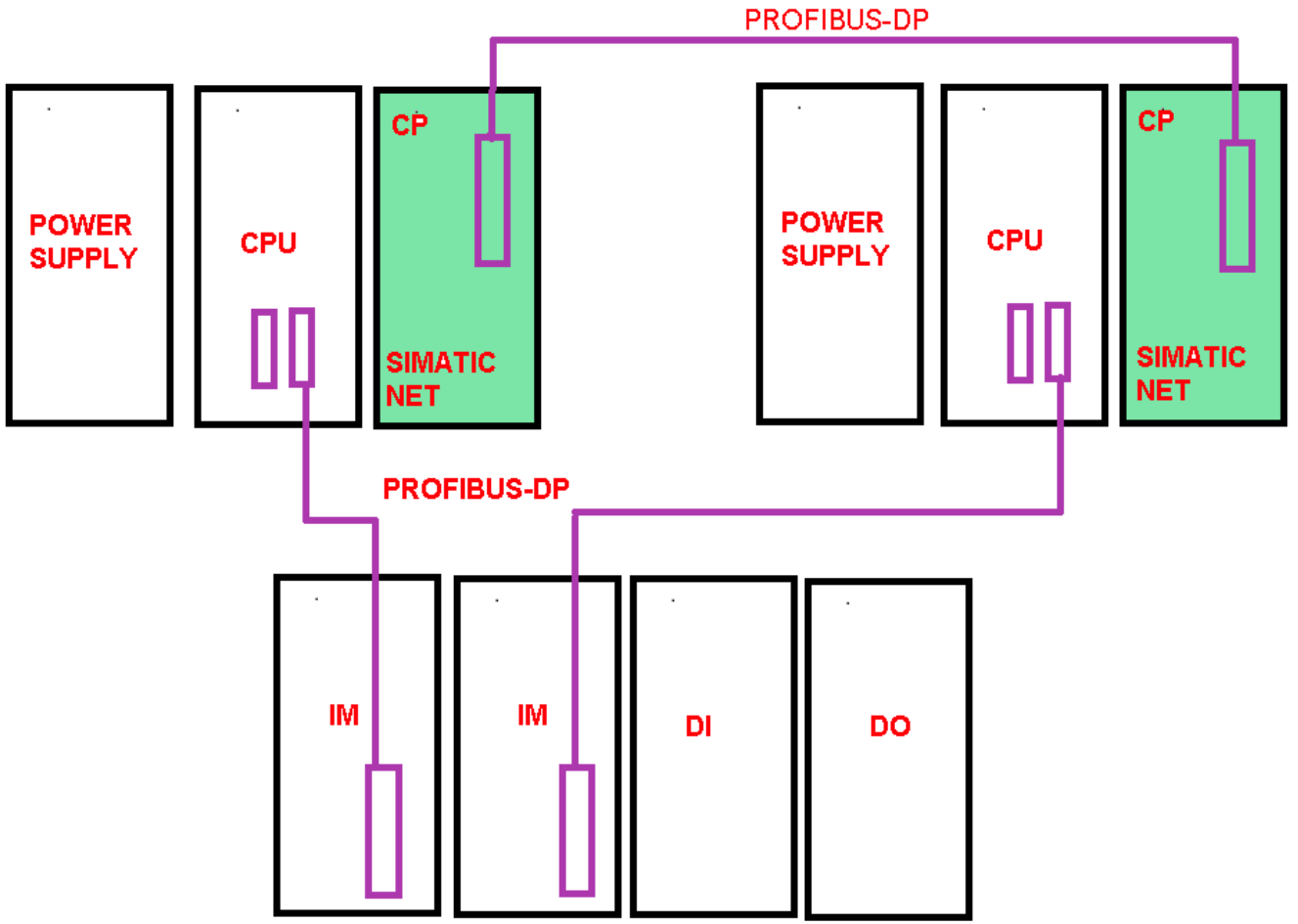
- FM do the following three things:
  - ➢ Convert the signal to processable data,
  - ➢ Process the data,
  - ➢ Convert the procced results back to electrical signals



Parts of a PLC Communication Processor

Communication Processor

- The CP (Communication processor) module is used to transfer the data in a case of not having the required port on your CPU.

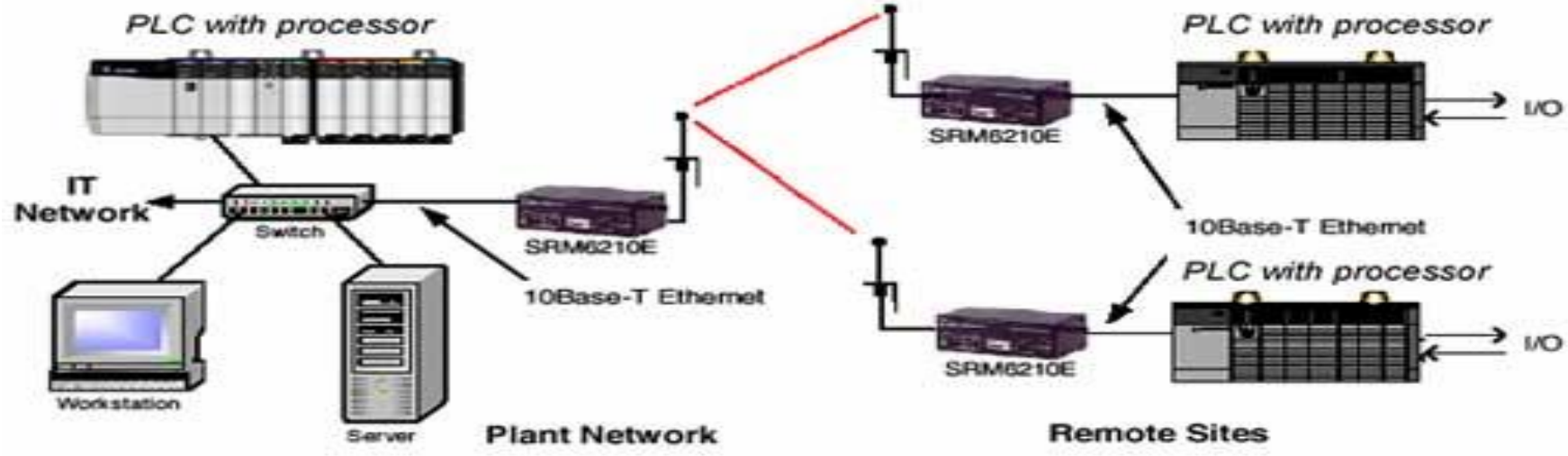


Special Modules

PLC communication modules

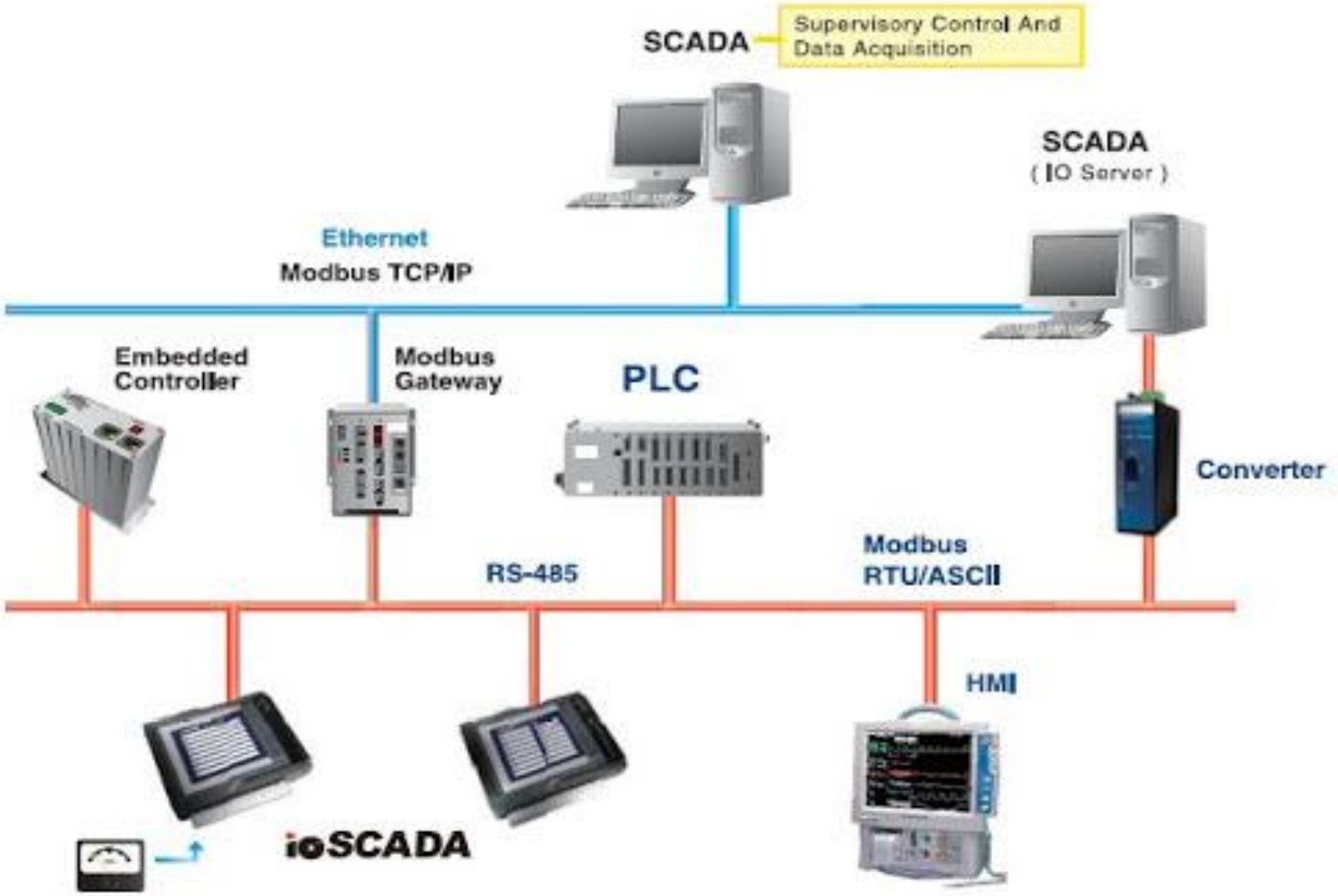
Communication modules digitally transfer data between PLCs and other devices within the factory facility. This becomes especially important as more factories are being equipped with Industrial Internet of Things (IIoT) or Industry 4.0 technology

1-LAN network



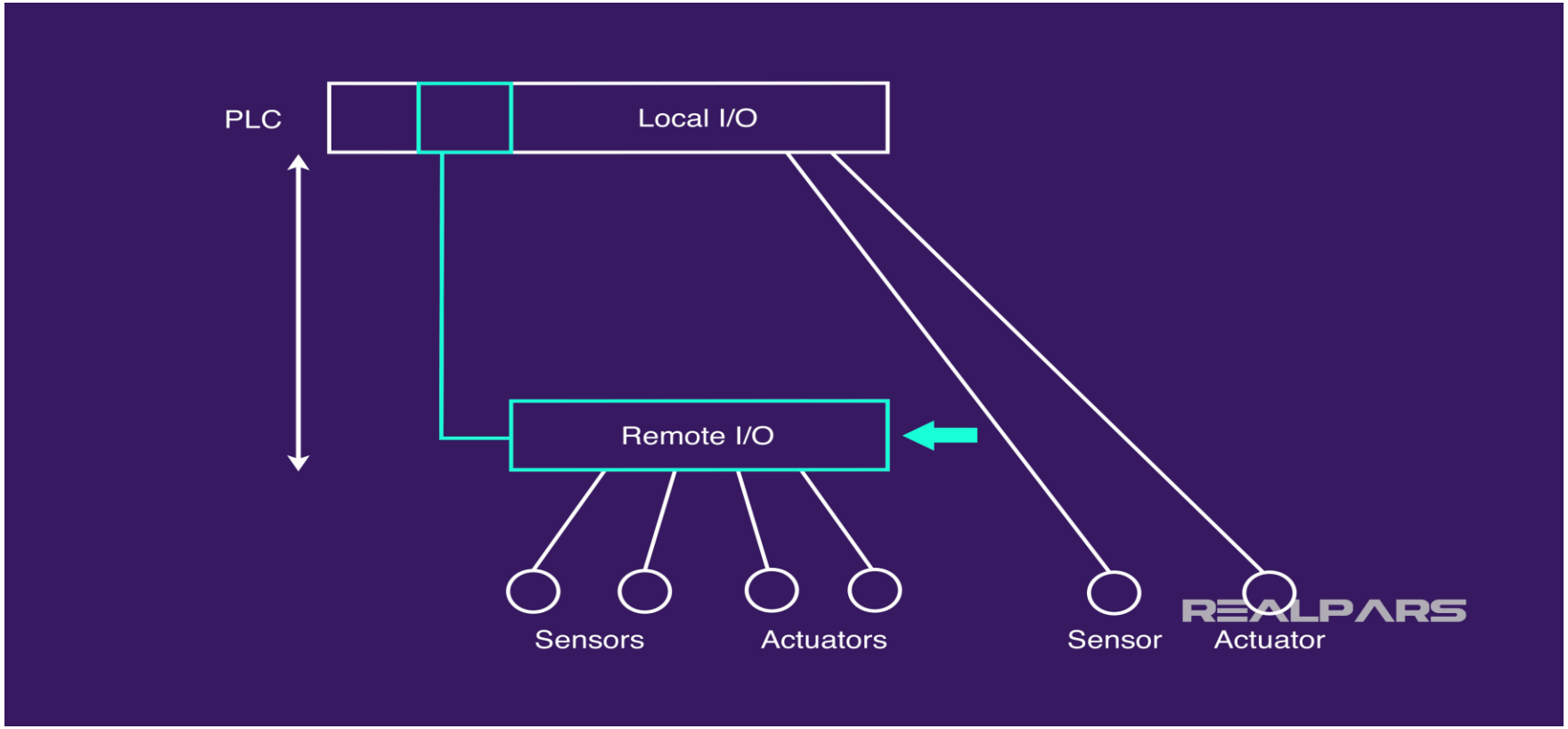
Special Modules

Communication Modules



Remote Module

Remote racks are used so that the location of the I/O modules can be near the field devices. This minimizes the amount of wiring required. i. Remote racks are used so that the location of the I/O modules can be near the field devices . This minimizes the amount of wiring required



PID Controller Module

PID controller is an instrument used in industrial control applications to regulate temperature, flow, pressure, speed and other process variables. PID (proportional integral derivative) controllers use a control loop feedback mechanism to control process variables and are the most accurate and stable controller